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(54) [Title] VLAN and VLAN frame switching device

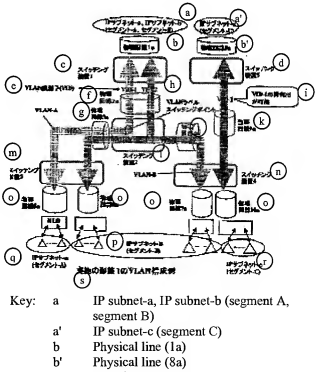
(57) Abstract

Problem

To simplify retrieval processing of the address and to adopt the method in a large scale network.

Means to solve

When a frame is input, header checking part (111) of input processing part (11) judges whether a VLAN tag is attached to the input frame. When it is not attached, the incoming IP address of the frame is taken as the key in retrieval of IP address/VID correspondence table (14), the input VID is derived and it is transmitted together with the frame to transfer processor (12); when the VLAN tag is attached, the received frame is transmitted as is to the transfer processor. In destination retrieval part (121) of the transfer processor, the input VID of the transmitted frame is used as a key in retrieval of VID/output port correspondence table (15), and it is sent to the output port.



Key:
- a IP subnet-a, IP subnet-b (segment A, segment B)
- a' IP subnet-c (segment C)
- b Physical line (1a)
- b' Physical line (8a)
- c Switching device (1)
- d Switching device (5)
- e VLAN identifier (VID)

f	Physical line (2a)
g	Physical line (3a)
h	VLAN label switching point
i	Reuse of VID-1 is allowed
j	Physical line (4a)
k	Physical line (9a)
l	Switching device (2)
m	Switching device (3)
n	Switching device (4)
o	Physical line (5a) Physical line (6a) Physical line (7a) Physical line (10a)
p	IP subnet B (segment B)
q	IP subnet a (segment A)
r	IP subnet c (segment C)
s	Example of constitution of VLAN in Embodiment 1

Claims

1. A VLAN frame switching device characterized by the following constitution: the segment is divided into IP subnet units, and IP subnet addresses and VLAN identifiers are mapped;

when a frame containing no VLAN tag is received, the assigned VLAN of the destination of the received frame is determined by means of the incoming IP address in the address, and the output port is determined by means of the assigned VLAN;

when a frame containing a VLAN tag is received, the output port of the destination of the received frame is determined by means of the VLAN identifier in the VLAN tag.

2. The VLAN frame switching device described in Claim 1, characterized by the following constitution: the VLAN identifier is handled as a label, and label switching is carried out by means of the VLAN identifier; as a result, the identifier of a VLAN with physical lines not repeating those of another VLAN is used repeatedly.

3. The VLAN frame switching device described in Claim 2, characterized by the constitution that label switching of a unicast by VLAN identifiers and label switching of multicasting are carried out.

4. A VLAN frame switching device characterized by the fact that in the frame switching device of a VLAN which has the segment divided into IP subnet units and has the IP subnet address and VLAN identifier mapped, there are the following parts:

a first table that stores the IP subnet address and the VLAN identifier corresponding to each other,

a second table that stores the VLAN identifier and output port corresponding to each other,

a means that works as follows: a judgment is made as to whether the received frame contains a VLAN tag; if NO, the VLAN identifier corresponding to the incoming IP address in the received frame is retrieved from said first table, and the output port corresponding to the VLAN identifier is retrieved from said second table; and if YES, the output port corresponding to the VLAN identifier in the VLAN tag is retrieved from said second table;

and a means that transmits the received frame via said retrieved output port.

5. The VLAN frame switching device described in Claim 4, characterized by the constitution wherein the received frame is discarded when the output port of said destination cannot be retrieved.

6. The VLAN frame switching device described in Claim 4 or 5, characterized by the constitution that when the received frame is a multicast frame and/or there are plurality of said retrieved output ports, the received frame is copied and transmitted.

7. The VLAN frame switching device described in any of Claims 4-6, characterized by the following constitution: it also has a third table that stores the correspondence relationship between the input VLAN identifier of the input port and the output VLAN identifier of the output port; the output VLAN identifier corresponding to the input VLAN identifier is retrieved from the third table; and the output VLAN identifier is set in the received frame for transmission.

8. A VLAN characterized in that the information of said first, second and third tables described in any of Claims 4-7 is transferred between the frame switching devices.

9. A VLAN characterized in that the information of the first, second and third tables described in any of Claims 4-7 is transferred from a server.

10. A VLAN characterized in that the information of said first, second and third tables described in any of Claims 4-9 is transferred by means of broadcasting.

11. A VLAN characterized in that the information of said first, second and third tables described in any of Claims 4-10 is transferred via the VLAN for management.

Detailed explanation of the invention

Technical field of the invention

The present invention pertains to VLAN (Virtual bridged Local Area Networks) and a VLAN frame switching device.

[0002]

Prior art

The prior art has VLAN as the frame switching system of the Layer 2 level of an IEEE standard, as described in the following references:

• IEEE Std 802.1Q-1998 "Virtual Bridged Local Area Networks"

• K. Seto et al.: "Gigabit Ethernet (R) Textbook," published by Asuki.

In the prior art, for example, this VLAN is a Layer 2 level virtual LAN system that considers the terminals scattered on various floors in a building or terminals having plural switches, such as a private LAN, etc., virtually as the same segment. Here, the same segment refers to the collision domain (collision detection region) and broadcast domain on the Layer 2 level, such as in the conventional Ethernet (R) (registered trademark).

[0003]

Figure 12 is a diagram illustrating an example of the constitution of the VLAN in the prior art. In this example of a VLAN, the VLAN consists of segment A and segment B. Here, segment A forms VLAN-A, and in VLAN-A, frame switching devices (1), (2), (3) are for use on physical lines (1a), (2a), (3a), (5a). Said segment B forms VLAN-B. In VLAN-B, frame switching devices (1), (2), (4) are for use on physical lines (1a), (4a), (6a), (7a). As shown in Figure 13, one means for forming a VLAN has a header for VLAN (VLAN tag) inserted in the frame, and the VLAN identifier (VID) is included in the VLAN tag, so that a VLAN is identified and constituted. Here, the VLAN identifier of VLAN-A is shown in Figure 12 as VID1, and the VLAN identifier of VLAN-B is shown as VID2. One VLAN identifier is assigned per VLAN, and it is unique in the network that forms the VLAN.

[0004]

The operation of the VLAN will be explained in the following. The frame processing for VLAN-A will be explained in more detail as an example.

(1) When frame switching device (1) receives a frame of segment A (with no VLAN tag) via physical line (1a), according to the input rule, input processing is carried out for recognizing the assigned VLAN of the received frame. In this example, because no VLAN tag is attached to the input frame, VLAN-A (VID1) as the assigned VLAN of the received frame is recognized from the transmission MAC address.

[0005]

(2) Then frame switching device (1) carries out transfer processing, and in this example, the destination port is retrieved from the incoming MAC address, and a check is performed to determine whether its destination port accommodates VLAN-A. If it is not accommodated, it is discarded, or other processing corresponding to it is carried out.

(3) Then, according to the output rule, frame switching device (1) carries out the output processing for outputting the frame with an appropriate format. In this example, the VLAN tag is generated and attached to the received frame, and it is output from physical line (2a).

[0006]

(4) When frame switching device (2) receives the frame (with a VLAN tag) from physical line (2a), according to the input rule, input processing is carried out for recognizing the assigned VLAN of the received frame. In this example, because the VLAN tag is attached to the input frame, VLAN-A (VID1) as the assigned VLAN of the received frame is recognized from the VLAN tag.

(5) Then frame switching device (2) carries out the transfer processing. In this example, the destination port is retrieved from the incoming MAC address, and a check is performed to determine whether the destination port accommodates VLAN-A. If not, discarding or other appropriate processing is carried out.

(6) Then, according to the output rule, said frame switching device (2) carries out the output processing for outputting a frame with the appropriate format. In this example, because the VLAN tag has been attached to the received frame, the VLAN tag is rewritten as needed and output from physical line (3a).

[0007]

(7) When frame switching device (3) receives the frame (with a VLAN tag) from physical line (3a), according to the input rule, input processing is carried out to recognize the assigned VLAN of the received frame. In this example, since the VLAN tag is attached to the input frame, VLAN-A (VID1) is recognized as the assigned VLAN of the received frame from the VLAN tag.

(8) Then said frame switching device (3) carries out transfer processing. In this example, the destination port is retrieved from the incoming MAC address, and a check is performed to determine whether its destination port accommodates VLAN-A. If not, discarding or other appropriate processing is carried out.

(9) Then, according to the output rule, said frame switching device (3) carries out the output processing for outputting a frame with the appropriate format. In this example, the VLAN tag is deleted from the received frame, and it is output from physical line (5a).

[0008]

The frame processing for VLAN-B is basically identical to that of VLAN-A, except that multipoint connection of VLAN-B is carried out. That is, in frame switching device (2), the result of retrieval of the output port from the incoming MAC address is output by physical lines (3a), (4a), and the frame is sent to physical lines (3a), (4a).

[0009]

Problems to be solved by the invention

However, the VLAN and VLAN frame switching device of the prior art have the following four problems.

(1) In the processing carried out in frame switching device (1), etc., when the VLAN tag is not attached to the received frame and the assigned VLAN is determined, retrieval is carried out with the transmission MAC address being used as the key, so that even when the hash method or the like is adopted, the table retrieval time still becomes O(1+N/B) on average, and a lot of time is needed. Here, N represents the number of elements in the hash table, and B represents the number of buckets in the hash table.

(2) When the output port is determined, for example, since the incoming MAC address is used as the key for retrieval even when the VLAN tag is contained in the frame, the table retrieval time is still long, with an average time of O(1+N/B), even when the same hash method or the like is adopted.

[0010]

(3) As can be seen from said problems (1), (2), it is necessary to register the MAC addresses one by one in the retrieval table. Consequently, as the network scale becomes larger, the number of the MAC addresses to be registered increases, so that the retrieval table also becomes larger, and scalability becomes a problem (it is difficult to apply it to a large scale networks).

(4) The VLAN identifier should be unique in the network of the Layer 2 level. Consequently, the maximum number of VLAN corresponds to the VID field length (12 bits), and is 4096. This also poses a major restriction to VLAN use in a large scale network.

[0011]

The purpose of the present invention is to solve the aforementioned problems of the prior art by providing a VLAN and a VLAN frame switching device characterized by the fact that it is possible to simplify address retrieval processing, and it is possible to apply it in large scale networks.

[0012]

Means to solve the problems

In order to realize the aforementioned purpose, the present invention provides a VLAN frame switching device characterized by the following constitution: the segment is divided into IP subnet units, and IP subnet addresses and VLAN identifiers are mapped; when a frame

containing no VLAN tag is received, the assigned VLAN of the destination of the received frame is determined by means of the incoming IP address in the address, and the output port is determined by means of the assigned VLAN; when a frame containing the VLAN tag is received, the output port of the destination of the received frame is determined by means of the VLAN identifier in the VLAN tag (Claim 1). With said constitution, the output port of the received frame is retrieved on an IP basis instead of a MAC basis, so that it is possible to simplify the processing of address retrieval, and it is possible to adopt it in large scale networks.

[0013]

For the VLAN frame switching device of the present invention, the VLAN identifier is handled as a label, and label switching is carried out by means of the VLAN identifier; as a result, the identifier of a VLAN with physical lines not repeating those of another VLAN is used repeatedly (Claim 2). With said constitution, because the VLAN identifier is repeatedly used, it is possible to adopt it in large scale networks even when the number of the VLAN identifiers is restricted.

[0014]

Also, for the VLAN frame switching device of the present invention, label switching of a unicast by VLAN identifiers and label switching of multicasting are carried out (Claim 3). With said constitution, it is possible to simplify the retrieval processing for addresses, and it can be adopted in large scale networks.

[0015]

The present invention also provides a VLAN frame switching device characterized by the fact that in the frame switching device of a VLAN which has the segment divided into IP subnet units and has the IP subnet address and VLAN identifier mapped, there are the following parts: a first table that stores the IP subnet address and the VLAN identifier corresponding to each other, a second table that stores the VLAN identifier and output port corresponding to each other, a means that works as follows: a judgment is made as to whether the received frame contains a VLAN tag; if NO, the VLAN identifier corresponding to the incoming IP address in the received frame is retrieved from said first table, and the output port corresponding to the VLAN identifier is retrieved from said second table; and if YES, the output port corresponding to the VLAN identifier in the VLAN tag is retrieved from said second table; and a means that transmits the received frame via said retrieved output port (Claim 4). With said constitution, the output port of the received frame is retrieved on an IP basis instead of a MAC basis, so that it is possible to simplify the retrieval processing of addresses, and it can be adopted in large scale networks.

[0016]

Also, for the VLAN frame switching device of the present invention, the received frame is discarded when the output port of said destination cannot be retrieved (Claim 5). For the VLAN frame switching device of the present invention, when the received frame is a multicast frame and/or there are plurality of said retrieved output ports, the received frame is copied and transmitted (Claim 6).

[0017]

For the VLAN frame switching device of the present invention, it also has a third table that stores the correspondence relationship between the input VLAN identifier of the input port and the output VLAN identifier of the output port; the output VLAN identifier corresponding to the input VLAN identifier is retrieved from the third table; and the output VLAN identifier is set in the received frame for transmission (Claim 7). With said constitution, it is possible to adopt it in large scale networks.

[0018]

The present invention provides a VLAN characterized in that the information of said first, second and third tables described in any of Claims 4-7 is transferred between the frame switching devices (Claim 8). Also, the present invention provides a VLAN characterized in that the information of the first, second and third tables described in any of Claims 4-7 is transferred from a server (Claim 9). In addition, the present invention provides a VLAN characterized in that the information of said first, second and third tables described in any of Claims 4-9 is transferred by means of broadcasting (Clam 10). In addition, the present invention also provides a VLAN characterized in that the information of said first, second and third tables described in any of Claims 4-10 is transferred via the VLAN for management (Claim 11).

[0019]

Embodiments of the invention

Embodiment 1

In the following, embodiments of the present invention will be explained with reference to figures. Figure 1 is a diagram illustrating the constitution of an embodiment of the VLAN of the present invention. Figure 2 is a block diagram illustrating in detail the frame switching device shown in Figure 1.

[0020]

The features of the present invention will be explained below. First of all, the present invention adopts IP-based-VLAN for simplifying the retrieval processing carried out to determine the assigned VLAN when the VLAN tag is not attached to the received frame, as in said problem (1), and for simplifying the retrieval table as in said problem (3). This method has the following features:

• The segment is divided into IP subnet units, and IP subnet and VLAN are mapped.

• As a result, when a "VLAN-tag-free frame " is received, the assigned VLAN and the output port are determined by means of the IP address instead of the MAC address.

[0021]

Because addresses can be collected for the IP address, the number of entries of the IP address retrieval table can be decreased from the number of entries of the MAC-based retrieval table. As a result, the IP-based retrieval time can be significantly decreased from the MAC-based retrieval time.

[0022]

Then, in order to simplify the retrieval processing when a VLAN tag is contained in the frame as in said problem (2), and to solve the limitation on the number of VLAN identifiers (VID) as in problem (4), VLAN label switching is adopted. This method has the following features: when a "frame with a VLAN tag" is received,

• When the output port is determined, the VID is directly retrieved instead of the MAC address.

• The VID is handled as a label, and VID attachment is carried out by means of the frame switching device, VID reuse is carried out, and the number of VLANs accommodated is increased.

[0023]

Because retrieval is carried out by means of VID, direct reference by Index becomes possible, and the time for table retrieval can be significantly decreased. In addition, because the VID is handled as a label, it is possible to reuse the VID value by carrying out VID value exchange in the frame switching device, and even when the number of VIDs is restricted, it is still possible to increase the number of VLANs accommodated.

[0024]

1) Explanation of constitution

Figure 1 shows an example of the VLAN constitution in Embodiment 1. The scheme shown in Figure 1 has the following features:

• Segments A, B, C are assigned to IP subnets a, b, c, respectively. That is, segment A is assigned to IP subnet a.

• Said IP subnets a, b, c and VLAN-A, VLAN-B, [sic; VLAN-C omitted] are mapped. For example, IP subnet a is mapped to VLAN-A.

[0025]

• The VLAN identifier (VID) for VLAN identification is handled as a label, and label switching is carried out by VID. For example, for VLAN-A, identification is carried out by means of VID1 between frame switching devices (1) and (2), and identification is carried out by means of VID2 between frame switching devices (2) and (3). Here, VID1 and VID2 can replace each other in frame switching device (2) as the VID of the VLAN tag in the frame.

• In VLAN-C, which is mapped to IP subnet c and has physical lines (8a), (9a), (10a) that do not overlap physical lines (1a)-(8a) of VLAN-A, VLAN-B, VID1 of VLAN-A is repeated in use as its VID. VID1 has been in use in VLAN-A (or VLAN-B). However, by using the VID as a label, it is possible to reuse it without superimposing VID value on the physical lines. Here, the VID in the network that forms a VLAN in the prior art is unique, and reuse is impossible.

[0026]

Figure 2 is a diagram illustrating the constitution of the frame switching device for realizing the aforementioned system. Basically, this frame switching device consists of input processor (11), transfer processor (12), output processor (13), IP subnet/VID correspondence table (14), VID/output port correspondence table (15), and VID input/output conversion correspondence table (16). Said input processor (11) consists of header checking part (111) that checks the header of the input frame and input filtering part (112) that carries out filtering of the frame. Said header checking part (111) uses IP subnet/VID correspondence table (14) as a reference.

[0027]

Said transfer processor (12) consists of destination retrieval part (121) that determines the destination port, frame copying part (122) that carries out copying of a multicast frame, and discard processor (123) that carries out processing of an address-unknown frame. Destination retrieval part (121) uses VID/output port correspondence table (15) as a reference. Said output

processor (13) consists of header editor (131) that edits the header of the output frame, and output filtering part (132) that carries out filtering of the output frame. Said header editor (131) uses VID input/output conversion correspondence table (16) as a reference.

[0028]

2) Explanation of operation

The operation of the frame switching device will be explained in the following. When a frame is input, header checking part (111) of input processor (11) judges whether a VLAN tag is attached to the input frame. If no VLAN is attached to the frame, the incoming IP address of the frame is used as the key for IP subnet/VID correspondence table (14) retrieval. The input VID is derived, and is transmitted together with the frame to transfer processor (12). On the other hand, if a VLAN tag is attached, input processor (11) transmits the received packet as is to transfer processor (12). Before transmission to transfer processor (12), input filtering part (112) carries out filtering (discarding or the like) of the frame based on the information of the IP address, input VID, etc.

[0029]

In destination retrieval part (121) of transfer processor (12), the input VID of the frame from input processor (11) is used as the key for VID/output port correspondence table (15) retrieval, and the output port is retrieved. If there are plural output ports in multipoint connection, frame copying part (122) copies the frame according to the number of output ports, and the frame and the input VID are transmitted to the output port output processor (13). In this case, if the output port of the frame is unclear, discard processor (123) discards the frame as a default. However, this does not apply if there is another instruction to discard processor (123).

[0030]

Header editor (131) of output processor (13) checks whether its output destination port is connected to the frame switching device. If it is connected to the frame switching device, it is judged that transmission is carried out in the format with the VLAN tag attached. If it is not connected to the frame switching device but is connected to a device that cannot recognize the VLAN tag, transmission is carried out in the format with the VLAN tag deleted.

[0031]

When transmission is in the format with a VLAN tag, header editor (131) retrieves VID input/output conversion correspondence table (16) based on the input VID and its own port identifier, derives the output VID, and inputs it into the VLAN tag of the output frame. Then

output filtering part (132) carries out filtering (discarding or the like) based on the IP address, output VID, etc., and the frame is output from the output port.

[0032]

VLAN setting

Here, the method for setting the new VLAN as shown in Embodiment 1 is a technical problem to be addressed. VLAN setting should be carried out for data setting of the three tables (14)-(16) shown in Embodiment 1. For example, when an IP subnet is added, because it is formed as a VLAN, it is necessary to set in the frame switching device the following tables needed in the VLAN constitution:

• IP subnet versus VID correspondence table (14) (IP subnet/VID correspondence table)

• Input VID versus output port correspondence table (VID/output port correspondence table)

• Input VID versus output VID correspondence table (16) (VID input/output conversion correspondence table) at the output port.

Schemes for VLAN setting include the distributed setting method and the concentrated setting method. In Embodiments 2 and 3, the distributed setting method is adopted, and in Embodiment 4, the concentrated setting method is adopted.

[0033]

Embodiment 2

1) Explanation of constitution

Figure 3 is a diagram illustrating an example of the constitution for VLAN setting. Figure 3 is a diagram illustrating the case when IP subnet a should be added to subordinate frame switching device (3), and VLAN-A of IP subnet a should be set (the same as in Embodiments 3 and 4 to be explained later). Basically, frame switching device (3) with IP subnet a added to it adopts the method for setting VLAN-A by broadcasting the added information to all of the other devices (1), (2), (4), (5). Consequently, as shown in Figure 4, VLAN setting processor (17) is added to the constitution of each frame switching device (1)-(5) shown in Figure 2. Here, VLAN setting up processor (17) has the function of analysis/editing/transmission of the VLAN setting message, and the function of setting up said three tables (14)-(16) based on the received VLAN setting message information.

[0034]

2) Explanation of operation

Figure 5 is a diagram illustrating the operation of VLAN setting processor (17). It shows the processing sequence between VLAN setting processors (17) of frame switching devices (1)-(5). Said VLAN setting processor (17) of frame switching device (3) (in the following explanation of this operation, only frame switching device (3) will be explained) works as follows: when the addition of IP subnet a by its subordinate (such as due to manual setting or the like) is recognized, frame switching device (3) broadcasts the VLAN setting request message, and it starts the setting end timing. The VLAN setting request message contains the added IP subnet address, and the port number for setting the new VLAN (consisting of physical lines, link number, etc.). If needed, other information may also be contained.

[0035]

Said frame switching device (2) that has received the VLAN setting request message checks whether the port number and other information assigned in the message is correct. If YES, the information is stored. Frame switching device (2) then selects the port number for extending the VLAN to frame switching devices (1), (4), and the VLAN extending request message is edited and sent to frame switching devices (1), (4).

[0036]

Said frame switching device (1) that has received the VLAN setting request message checks whether the port number assigned by the message is correct. If YES, the information is stored. Here, frame switching device (1) itself accommodates IP subnet a contained in the VLAN setting request message. Consequently, VID (VID1) is selected for assembling VLAN-A on physical line (2a). Here the correspondence relationship between the address of IP subnet a and VID1 is set in IP subnet/VID correspondence table (14), and the correspondence relationship between VID1 and physical line (2a) is set in VID/output port correspondence table (15). The VLAN setting request message containing the selected VID is transmitted to frame switching device (2). Also, frame switching device (1) transmits the VLAN setting request message to frame switching device (5).

[0037]

Here, frame switching device (4), which has received the VLAN setting request message, does not itself accommodate IP subnet a contained in the VLAN setting request message. Consequently, the VLAN setting request message is not transmitted, and only the VLAN setting

request message is edited and transmitted to frame switching device (5). The same processing is also carried out in frame switching device (5).

[0038]

On the other hand, frame switching device (2), which has received the VLAN setting request message, selects VID (VID2) for assembling VLAN-A on physical line (3a); it has VID (VID1) in the message correspond to the selected VID2, and sets them in VID input/output conversion correspondence table (16). Also, it is set in VID/output port correspondence table (15) that VID1 corresponds to physical line (3a), and VID2 corresponds to physical line (2a). Here, the VLAN setting request message contained in VID2 is edited and is transmitted to frame switching device (3).

[0039]

Said frame switching device (3) sets up the VLAN corresponding to the VLAN setting response reached during setting end timer start. That is, in IP subnet/VID correspondence table (14), the correspondence relationship between the address of IP subnet a and frame switching device (2) is set in IP subnet/VID correspondence table (14), and the correspondence relationship between VID2 and physical line (3a) is set in VID/output port correspondence table (15). With the aforementioned operation, VLAN-A is set for IP subnet a.

[0040]

Embodiment 3

The constitution of Embodiment 3 adopts the same distributed setting method as in Embodiment 2, except that VLAN is set for management beforehand, and the VLAN setting message uses the management VLAN for transfer.

[0041]

1) Explanation of constitution

Figure 6 is a diagram illustrating an example of the constitution of Embodiment 3. Here, the VLAN for management in setting the VLAN beforehand is arranged between all of frame switching devices (1)-(5). Here, the management VLAN is arranged between frame switching devices (1)-(5), except that no management VLAN is set up between frame switching devices (1) and (5). Consequently, as shown in Figure 7, said frame switching devices (1)-(5) has management VLAN setting processor (18) in addition to VLAN setting processor (17) in Embodiment 2.

[0042]

Here, when the system is turned on or the frame switching device is added/deleted, management VLAN setting processor (18) is started, and the spanning tree's management VLAN is set so that a loop will not occur. Also, although no detailed explanation has been made for the management VLAN setting method since this is outside the range of the present invention, a specific method is adopted to set the management VLAN. Here the default value = VID0 is used as the VID of said management VLAN.

[0043]

2) Explanation of operation

Figure 8 is a diagram illustrating the operation of management VLAN setting processor (18). It shows the processing sequence between management VLAN setting processors (18) of various frame switching devices (1)-(5). Basically, the processing sequence is identical to that of Embodiment 2, except that where frame switching device (1) transmitted the VLAN setting request message to frame switching device (5) in Embodiment 2, in the present embodiment the management VLAN is used to transmit the VLAN setting message, so that frame switching device (1) does not transmit the VLAN setting message to frame switching device (5).

[0044]

3) Explanation of the effect

Since VLAN for management VLAN setting message is used for transmission, compared to the second embodiment, the range wherein VLAN setting message is broadcast is limited (only transmitted to the minimum essential number of frame switching devices) so that the amount of traffic is reduced.

[0045]

Embodiment 4

Embodiment 4 differs from Embodiments 2 and 3 in that it adopts the concentrated setting method. A server for VLAN setting is prepared. The VLAN setting message is transmitted from said server to all frame switching devices (1)-(5). A management VLAN is set between said VLAN setting server and frame switching devices (1)-(5).

[0046]

1) Explanation of constitution

Figure 9 shows an example of VLAN setting in Embodiment 4. In this example, the management VLAN for VLAN setting is arranged beforehand between all of the frame

switching devices (1)-(5) and VLAN setting server (20). Here, VLAN setting server (20) is connected to frame switching device (5), and VLAN setting server (20) and all of the frame switching devices (1)-(5) are connected by means of the management VLAN.

[0047]

From VLAN setting server (20), the VLAN setting message is transmitted through the management VLAN to a required frame switching device. Based on the information in the message, each frame switching device sets the VLAN. Just as in Embodiment 3, the method for setting the management VLAN is outside the range of the present invention. A specific method will be adopted to set the management VLAN. Also, the constitution of frame switching devices (1)-(5) is the same as that in Embodiment 3, so that it will not be explained in detail again. Figure 10 illustrates an example of the constitution of VLAN setting server (20).

[0048]

Here, VLAN setting server (20) consists of management VLAN setting processor (21), VLAN setting processor (22), input processor (23), output processor (24), and IP subnet/VID correspondence table (25), for each frame switching device (1)-(5), as well as VID/output port correspondence table (26), and VID input/output conversion correspondence table (27).

[0049]

Said input processor (23) judges the type of an input message, and allots it to management VLAN setting processor (21) and VLAN setting processor (22). Said management VLAN setting processor (21) carries out processing for setting the management VLAN. However, no detailed explanation of it will be given here. Said VLAN setting processor (22) carries out the processing to set the VLAN that transfers the user data, as will be explained later. Said output processor (24) is a processing part that carries out transfer of messages pertaining to the setting processing according to instructions from management VLAN setting processor (21) and VLAN setting processor (22). The three tables (25)-(27) are used as references as needed by management VLAN setting processor (21) and VLAN setting processor (22).

[0050]

2) Explanation of operation

Figure 11 is a diagram illustrating an operation example. Here, frame switching device (3), which has recognized the fact of addition of IP subnet a, uses the management VLAN with respect to VLAN setting server (20) to send the VLAN request message. When VLAN setting server (20) receives the request message, the frame switching device needed for arranging the

VLAN for adding IP subnet a is determined. In this example, there are frame switching devices (1), (2), (3), and, the VLAN setting request message is sent to them. Said setting request message contains the IP subnet address and the VLAN's VID, and the port number in each frame switching device where said VLAN should be arranged.

[0051]

Said frame switching devices (1), (2), (3) that have received the setting request message set the VLAN based on the information in the message, and after VLAN setting, a VLAN setting response message is transmitted to VLAN setting server (20). Here, VLAN setting server (20) recognizes that VLAN setting has ended when the VLAN setting response messages from all of the frame switching devices (1), (2), (3) that sent VLAN setting messages have been received.

[0052]

3) Explanation of the effect

By providing VLAN setting server (20), it is possible to achieve batch management of the type of VLAN set. Consequently, it is believed that, compared to Embodiments 2 and 3, it is possible to simplify VLAN malfunction detection/correspondence, etc.

[0053]

Effects of the invention

As explained above, according to the present invention, the segment is divided into IP subnet units, and the IP subnet address and the VLAN identifier are mapped; the output port of the received frame is retrieved on an IP basis instead of on a MAC basis. Consequently, it is possible to simplify the processing for address retrieval. Also, it is possible to adopt it in large scale networks.

Brief description of the figures

Figure 1 is a diagram illustrating the constitution of a VLAN in an embodiment of the present invention.

Figure 2 is a block diagram illustrating in detail the constitution of the frame switching device in Figure 1.

Figure 3 is a diagram illustrating the VLAN constitution in Embodiment 2.

Figure 4 is a block diagram illustrating in detail the frame switching device in Figure 3.

Figure 5 is a diagram illustrating the VLAN setting processing sequence of the VLAN in Figure 3.

Figure 6 is a diagram illustrating the VLAN constitution in Embodiment 3.

Figure 7 is a block diagram illustrating in detail the constitution of the frame switching device in Figure 6.

Figure 8 is a diagram illustrating the VLAN setting processing sequence for the VLAN in Figure 6.

Figure 9 is a diagram illustrating the constitution of the VLAN in Embodiment 4.

Figure 10 is a block diagram illustrating in detail the constitution of the VLAN setting server in Figure 6 [sic; Figure 9].

Figure 11 is a diagram illustrating the VLAN setting processing sequence of the VLAN in Figure 9.

Figure 12 is a diagram illustrating the constitution of a VLAN in the prior art.

Figure 13 is a diagram illustrating the format of a VLAN tag.

Explanation of symbols

A-C Segment
a-c IP subnet
1-5 Frame switching device
1a-10a Physical line
11 Input processor
12 Transfer processor
13 Output processor
14 IP subnet/VID correspondence table
15 VID/output port correspondence table
16 VID input/output conversion correspondence table
17 VLAN setting processor
18 Management VLAN setting processor
20 VLAN setting server

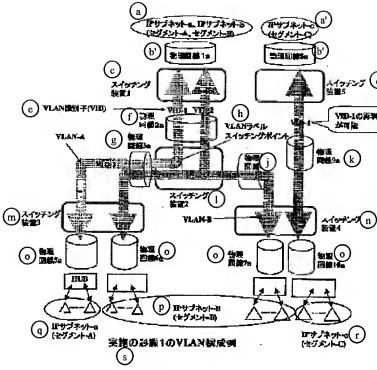


Figure 1

Key:
- a IP subnet-a, IP subnet-b (segment A, segment B)
- a' IP subnet-c (segment C)
- b Physical line (1a)
- b' Physical line (8a)
- c Switching device (1)
- d Switching device (5)
- e VLAN identifier (VID)
- f Physical line (2a)
- g Physical line (3a)
- h VLAN label switching point
- i Reuse of VID-1 is allowed
- j Physical line (4a)
- k Physical line (9a)
- l Switching device (2)
- m Switching device (3)
- n Switching device (4)
- o Physical line ___
- p IP subnet B (segment B)
- q IP subnet a (segment A)
- r IP subnet c (segment C)
- s Example of constitution of VLAN in Embodiment 1

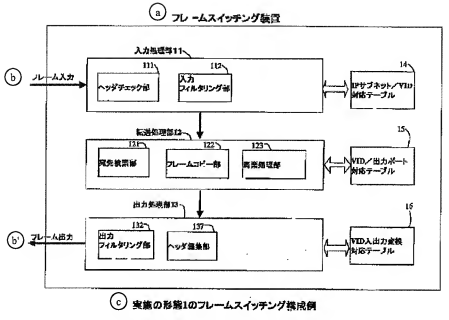


Figure 2

Key:
- a Frame switching device
- b Frame input
- b' Frame output
- c Example of constitution of frame switching in Embodiment 1
- 11 Input processor
- 111 Header checking part
- 112 Input filtering part
- 12 Transfer processor
- 121 Destination retrieval part
- 122 Frame copying part
- 123 Discard processor
- 13 Output processor
- 132 Output filtering part
- 137 Header editor
- 14 IP subnet/VID correspondence table
- 15 VID/output port correspondence table
- 16 VID input/output conversion correspondence table

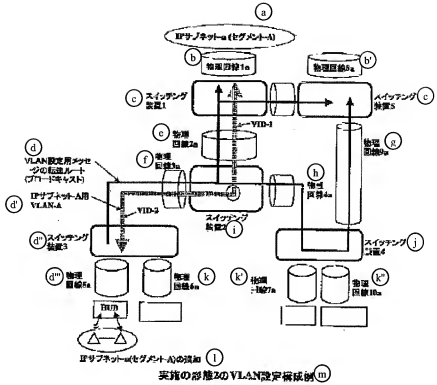


Figure 3

Key:

	a	IP subnet-a (segment A, segment B)
	b	Physical line (1a)
	b'	Physical line (8a)
	c	Switching device (1)
	c'	Switching device (5)
	d	Transfer route of message for setting VLAN (broadcast)
	d'	VLAN-A for IP subnet A
	d''	Switching device (3)
	d'''	Physical line (5a)
	e	Physical line 2a
	f	Physical line (3a)
	g	Physical line (9a)
	h	Physical line (4a)
	i	Switching device (2)
	j	Switching device (4)
	k	Physical line 6a
	k'	Physical line 7a
	k''	Physical line 10a
	l	Addition of IP subnet a (segment A)
	m	Example of constitution of VLAN setting in Embodiment 2

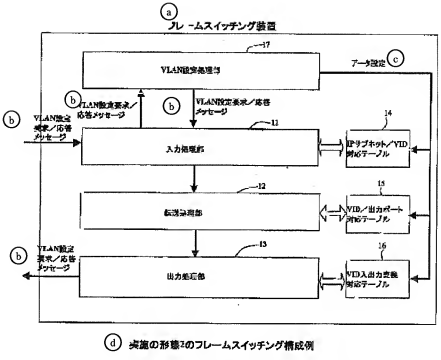


Figure 4

Key:
- a Frame switching device
- b VLAN setting request/response message
- c Data setting
- d Example of constitution of frame switching in Embodiment 2
- 11 Input processor
- 12 Transfer processor
- 13 Output processor
- 14 IP subnet/VID correspondence table
- 15 VID/output port correspondence table
- 16 VID input/output conversion correspondence table
- 17 VLAN setting processor

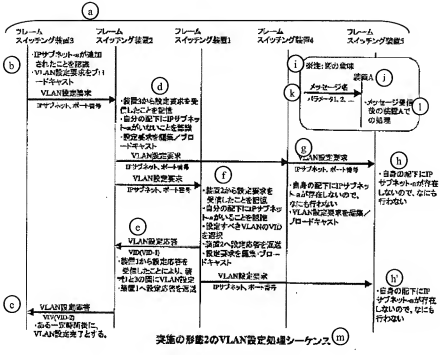


Figure 5

Key: a Frame switching device ___

b
- Recognition of addition of IP subnet a
- Broadcast of VLAN setting request

VLAN setting request

IP subnet, port number

c VLAN setting response

VIV (VID-2)
- End of VLAN setting after a prescribed time

d
- Storage of the fact that setting request from device (3) is received
- Recognition that there is no IP subnet a below itself
- Editing/broadcast of setting request

VLAN setting request

IP subnet, port number

VLAN setting request

IP subnet, port number

e VLAN setting response

VID (VID-1)
- Due to reception of setting response from device (1), VLAN is set between devices (1) and (3)
- Return of setting response to device (1)

f • Storage of the fact of reception of setting request from device (2)
• Recognition of presence of IP subnet a below itself
• Selection of VID of VLAN to be set
• Return of setting response to device (2)
• Editing, broadcast of setting request
VLAN setting request

IP subnet, port number

g VLAN setting request

IP subnet, port number
• Because there us no IP subnet a below itself, nothing is executed.
• VLAN setting request is edited/broadcast

h • Because there is no IP subnet a below itself, nothing is executed.

h' • Because there is no IP subnet a below itself, nothing is executed.

i *Note: Meaning of figure

j Device A

k Message name

Parameters 1, 2....

l • Processing performed in device A after reception of message

m Sequence of VLAN setting processing in Embodiment 2

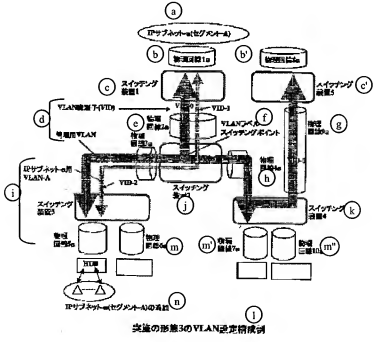
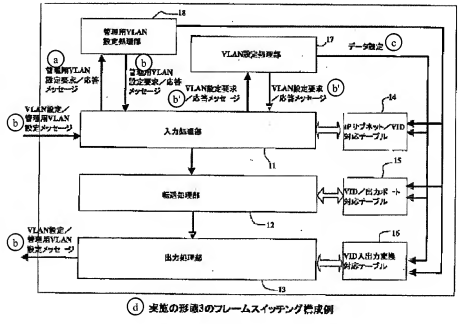


Figure 6

Key: a IP subnet-a (segment A)

b Physical line (1a)

b' Physical line (8a)
c Switching device (1)
c' Switching device (5)
d VLAN identifier (VID)
Management VLAN
e Physical line (2a)
Physical line (3a)
f VLAN label switching point
g Physical line (9a)
h Physical line (4a)
i VLAN-A for IP subnet a
Switching device (3)
Physical line (5a)
j Switching device (2)
k Switching device (4)
l Example of constitution for setting VLAN in Embodiment 3
m Physical line (6a)
m' Physical line (7a)
m" Physical line (10a)
n Addition of IP subnet a (segment A)



d 実施の形態3のフレームスイッチング構成例

Figure 7

Key: a Management VLAN setting request/response message
b VLAN setting/management VLAN setting message
b' VLAN setting request/response message
c Data setting
d Example of constitution of frame switching in Embodiment 3

11 Input processor
12 Transfer processor
13 Output processor
14 IP subnet/VID correspondence table
15 VID/output port correspondence table
16 VID input/output conversion correspondence table
17 VLAN setting processor
18 Management VLAN setting processor

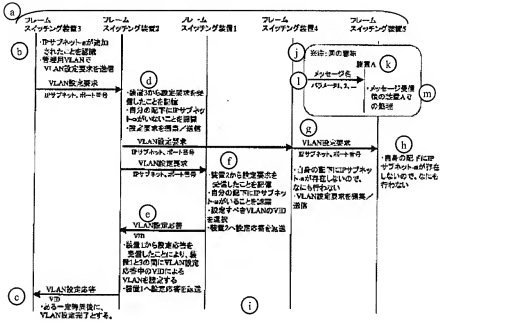


Figure 8

Key: a Frame switching device ___
b • Recognition of addition of IP subnet a
• Transmission of VLAN setting request by management VLAN
VLAN setting request

IP subnet, port number
c VLAN setting response

VID-2
• End of VLAN setting after a prescribed time
d • Storage of the fact that setting request from device (3) is received
• Recognition that there is no IP subnet a below itself
• Editing/broadcast of setting request
VLAN setting request

IP subnet, port number
VLAN setting request

IP subnet, port number

e VLAN setting response

VID-1

• Due to reception of setting response from device (1), VLAN is set between devices (1) and (3) due to VID during VLAN setting response

• Return of setting response to device (1)

f • Storage of the fact of reception of setting request from device (2)

• Recognition of presence of IP subnet a below itself

• Selection of VID of VLAN to be set

• Return of setting response to device (2)

g VLAN setting request

IP subnet, port number

• Because there is no IP subnet a below itself, nothing is executed.

• VLAN setting request is edited/broadcast

h • Because there is no IP subnet a below itself, nothing is executed.

i Example of sequence of VLAN setting processing sequence in Embodiment 3

j *Note: Meaning of figure

k Device A

l Message name

Parameters 1, 2....

m • Processing performed in device A after reception of message

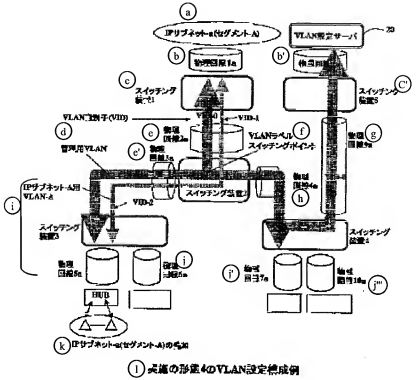
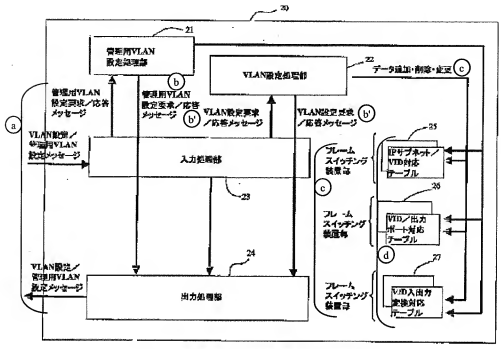


Figure 9

Key:
- a IP subnet-a (segment A)
- b Physical line (1a)
- b' Physical line (8a)
- c Switching device (1)
- c' Switching device (5)
- d VLAN identifier (VID)
  Management VLAN
- e Physical line (2a)
- e' Physical line (3a)
- f VLAN label switching point
- g Physical line (9a)
- h Physical line (4a)
- i VLAN-A for IP subnet a
  Switching device (3)
  Physical line (5a)
- j Physical line (6a)
- j' Physical line (7a)
- j" Physical line (10a)
- k Addition of IP subnet a (segment A)
- l Example of constitution for setting VLAN in Embodiment 4
- 20 VLAN setting server



ⓕ 実施の形態4のVLAN設定サーバ構成例

Figure 10

Key:
- a — Management VLAN setting request/response message; VLAN setting/management VLAN setting; VLAN setting/management VLAN setting
- b — Management VLAN setting request/response message
- b' — VLAN setting request/response message
- c — For each frame switching device
- d — IP subnet/VID correspondence table; VID/output port correspondence table; VID input/output conversion correspondence table
- e — Data addition/deletion/change
- f — Example of constitution of VLAN setting server in Embodiment 4
- 21 — Management VLAN setting processor
- 22 — VLAN setting processor
- 23 — Input processor
- 24 — Output processor

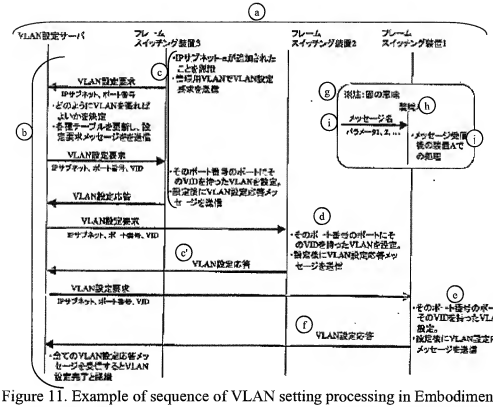


Figure 11. Example of sequence of VLAN setting processing in Embodiment 4

Key: a VLAN setting server
Frame switching device (3)
Frame switching device (2)
Frame switching device (1)

b • Recognition of VLAN setting

IP subnet, port number
• Determine how to arrange VLAN
• Refreshing of various types of tables, transmission of setting request message
VLAN setting request

IP subnet, port number, VID
VLAN setting response

VLAN setting request

IP subnet, port number, VID

VLAN setting request

IP subnet, port number, VID

• When all of the messages of VLAN setting response have been received, it is recognized that VLAN setting has come to an end

c • Recognition of addition of IP subnet a
• Transmission of VLAN setting request by means of management VLAN
• Setting of VLAN with VID to the port of its port number
• Transmission of VLAN setting response message after setting

c' VLAN setting response

d • Setting of VLAN having VID to the port of the port number
• Transmission of VLAN setting response message after setting

e • Setting of VLAN having VID to the port of its port number
• Transmission of VLAN setting response message after setting

f VLAN setting response

g *Note: Meaning of figure

h Device A

i Message name

Parameters 1, 2....

j • Processing performed in device A after reception of message

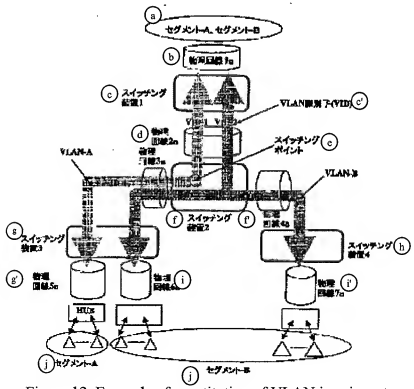


Figure 12. Example of constitution of VLAN in prior art

Key: a Segment A, segment B
b Physical line (1a)
c Switching device (1)
c' VLAN identifier (VID)
d Physical line (2a)
Physical line (3a)

e Switching point
f Switching device (2)
f' Physical line (4a)
g Switching device (3)
g' Physical line (5a)
h Switching device (4)
i Physical line (6a)
i' Physical line (7a)
j Segment ___

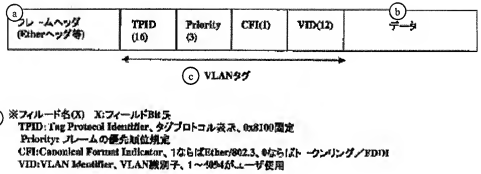


Figure 13. Example of VLAN tag format

Key: a Frame header (Ether header, etc.)
b Data
c VLAN tag
d * Field name (X), X: field bit length
TPID: Tag Protocol Identifier, tag protocol display, 0x8100 fixed
Priority: Defines the priority order of frame
CFI: Canonical Format Indicator, If 1, Ether/802.3; if 0, token ring/FDDI
VID: VLAN Identifier, VLAN identifying unit, 1-4094 for use by user